392.1 DESCRIPTION

This work consists of hydraulic pressure jacking PCC pavement to correct the pavement profile. Jacking is accomplished by drilling injection holes and pumping a cement/fly ash slurry or liquid polyurethane (foam) under the slab.

392.2 MATERIALS

A. Jacking Slurry Design Mix: The design mix for grout shall conform to the following proportions by absolute volume:

1 Part Portland cement
3 Parts fly ash
Water to achieve the specified fluidity

Fluidity of the grout when measured by a flow cone in accordance with ASTM C939 shall have a time of efflux between 16 and 36 seconds. During initial injection at each hole an efflux time between 9 and 15 seconds will be permitted. The use of material with an efflux time between 9 and 15 seconds shall be discontinued prior to movement of the pavement. The Contractor shall be required to perform this test prior to placing any material.

The Contractor shall submit for approval, materials proposed for use. The submittal shall include mill certification for cement, physical and chemical analysis for fly ash, and tests of the grout slurry by a reputable testing laboratory. Tests shall show one, three, and seven day strengths, flow cone times, shrinkage and expansion observed, and time of initial set. The seven day strength shall be at least 600 psi (4.1 MPa) as measured in accordance with ASTM C942. As an alternate, standard 6 inch (152.4 mm) diameter by 12 inch (304.8 mm) high water tight concrete cylinder molds may be used to determine seven day strength. When the cylinder molds are used, the strength shall be 700 psi. (4.8 MPa) minimum.

B. Portland Cement: Type 1 or Type 2 cement shall be required, and the cement shall meet the requirements of Section 750.

C. Fly Ash: Fly ash shall conform to Section 753.

D. Water: Water shall conform to Section 790.

E. Jacking Foam: Water blown formulation of high-density polyurethane. The high density, closed cell polyurethane shall be hydrophobic and shall exhibit the following physical characteristics and properties:

Density, Lb/Cu Ft (ASTM D1622)	Compressive Strength (ASTM D1621)
3.0 (48 kg/m^3)	40 psi (275 kPa)
3.5 (56 kg/m^3)	50 psi (344 kPa)
4.0 (64 kg/m^3)	60 psi (413 kPa)
6.0 (96 kg/m^3)	110 psi (758 kPa)

The polyurethane foam shall have a free rise density of 3.0 to 3.2 lbs/cu ft (48 to 51 kg/m^3), with a minimum compressive strength of 40 psi (275 kPa). The material shall be resistant to oils, gasoline and most solvents.

The high-density polyurethane formulation shall reach 90% of full compressive strength within 15 minutes from injection.

392.3 CONSTRUCTION REQUIREMENTS

A. General: The Contractor, or subcontractor performing the pavement jacking shall have prior experience with pavement jacking operations, and shall have personnel on the project with expertise in determining injection hole patterns and jacking sequences. Prior to awarding the contract, the Department may require the Contractor to substantiate previous experience with this type of work. The Contractor, upon Department request, shall be required to submit a list of at least three projects on which the Contractor or the pavement jacking subcontractor have satisfactorily completed similar work.

The Contractor shall not start any new location unless it can be completed in the same day. If any location is started and cannot be completed prior to the end of the day's work, the entire area, including adjacent lanes, shall be undersealed in accordance with Section 391 before stopping for the day. If PCC Pavement Foam Jacking is specified, foam may be used to underseal adjacent areas.

The Contractor shall take the necessary precautions to avoid slurry or foam from entering areas such as pipes, culverts, voids behind abutments or other such areas that may hinder the functionality of the roadway. If foam or slurry enters these areas, it shall be removed to the satisfaction of the Engineer at no additional expense to the State.

B. Weather and Seasonal Limitations: Pavement jacking shall not be performed when the pavement surface temperatures are below 40° F (4° C), or if the subgrade or base course is frozen. Pavement jacking shall not be performed when the subgrade contains an abnormal amount of moisture from recent rainfall, as evidenced by standing water on the pavement or in the joints or cracks.

C. Equipment:

1. Grout Plant: When jacking slurry is specified, the grout plant shall consist of a positive displacement cement injection pump and a high speed colloidal mixing machine. The colloidal mixing machine shall operate between 800 and 2000 RPM, creating a high shearing action and subsequent pressure release to make a homogeneous mixture.

2. **Drilling:** An air compressor and rock drills or other devices capable of drilling the injection holes through the pavement shall be required.

3. **Pumping Unit:** When Jacking Foam is specified, the Contractor shall furnish a truck-mounted pumping unit capable of injecting the high-density polyurethane formulation between the concrete pavement and the subbase and capable of controlling the rate of rise of the pavement. The pumping unit shall be equipped with a metering device to measure the quantity of material pumped.

4. **Laser Leveling Unit:** The Contractor shall furnish a laser leveling unit to ensure that the concrete is raised to an even plane and to the required elevation.

D. Drilling Holes:

When jacking slurry is specified, a hole pattern for grout injection will be determined by the Engineer in consultation with the Contractor. The Engineer may delete any location or add new locations of pavement to be raised. Holes shall be between 1.5 and 2 inches (38 and 50 mm) in diameter, drilled vertically and round, to a depth sufficient to penetrate any stabilized base and into the subgrade material. Holes may be washed to create a small cavity, allowing initial spread of grout. Holes shall be drilled in a manner that prevents breakout at the bottom of the pavement. The downward force of the drill shall not exceed 200 pounds (0.89 kN). Variations from plans quantity will not be considered cause for renegotiations of the contract unit prices.

When jacking foam is specified, a hole pattern for injection will be determined by the Contractor in consultation with the Engineer. The Engineer may delete any location or add new locations of pavement to be raised. Holes shall be 5/8 inch (16 mm) in diameter, drilled vertically and round to a depth sufficient to penetrate any stabilized base and in the subgrade material. Holes shall be drilled in a manner that prevents breakout at the bottom of the pavement.

E. Slurry Pavement Jacking: String lines shall be established and blocked up from the pavement high points to monitor movement.

An expanding rubber packer or other approved device connected to the discharge from the plant shall be lowered into the hole. The discharge end of the packer or hose shall not extend below the lower surface of the concrete pavement.

The Contractor shall pump in a pattern and in the amount required to raise the pavement to within 0.02 foot (6 mm) of the specified grade. Grade tolerances are applicable to both transverse and longitudinal grades. After the pavement has been raised to the desired elevation, all holes shall be injected to ensure complete filling of voids.

Continuous pressures up to 200 psi (1.4 MPa) will be permitted. Pressures up to 300 psi (2.1 MPa) will be allowed only for short periods. If the pavement is bonded to the subbase, brief pressure rises (10 seconds or less) up to 600 psi (4.1 MPa) will be allowed.

Mixed material shall not be held in the mixer or injection sump pump for more than one hour after mixing. Any material held longer than one hour shall be wasted and will not be paid for. Additional water shall not be added after initial mixing of the grout.

Excessive loss of the slurry through cracks, joints, other drilled holes, or from back pressure in the hose or in the shoulder area will not be tolerated and will not be paid for.

If the Engineer determines that continued slurry injection at a specific location is no longer feasible due to major voids he may direct the Contractor to cease slurry injection at that location.

Upon completion of jacking and prior to the injection slurry drying on the sides of the drill holes, the drill holes shall be filled with a fast setting sand/cement mixture or other patch material approved by the Engineer. If the injection slurry has dried on the sides of the drill holes, the sides of the drill holes shall be sand blasted and blown out prior to filling the holes with fast setting sand/cement mixture.

F. Foam Pavement Jacking: The high-density polyurethane formulation is to be injected under the slab. The amount of rise shall be controlled using the pumping unit and by regulating the rate of injection.

The Contractor shall inject in a pattern and in the amount required to raise the pavement to within 0.02 foot (6mm) of the specified grade. Grade tolerances are applicable to both transverse and longitudinal grades. A tight string line and/or laser level shall be used to monitor and verify elevations. After the pavement has been raised to the desired elevation, all holes shall be injected to ensure complete filling of voids.

Excessive loss though crack, joints, other drilled holes, from back pressure in the hose, in the shoulder area or as a result of cleaning lines will not be paid for. The Contractor shall provide a scale for weighing the waste material.

If the Engineer determines that continued foam injection at a specific location is no longer feasible due to major voids, he may direct the Contractor to cease foam injection at the location.

Upon completion of the jacking, the upper 2 inches (50 mm) of the drilled holes shall be filled with a fast setting sand/cement mixture or other patch material approved by the Engineer. The foam material shall be removed from the injection hole appropriately to ensure a good bond between the fast setting sand/cement mixture and the in-place concrete.

G. Radial Cracks: The slab shall not be raised more than 1/4 inch (6 mm) while pumping in any one hole at any one time. Cracks emanating radially from the grout injection holes will be presumed to have been caused by improper injection techniques by the Contractor. For each five feet (5 m) of crack measured, the pay quantity will be reduced by one cubic foot (0.1 cubic meter) of grout or 10 pounds (5 kg) of polyurethane foam material.

H. Transverse Cracks: If cracks develop between adjacent grout injection holes, the Contractor shall repair the cracks by a satisfactory method approved by the Engineer.

I. Pavement Raised above Tolerances: Pavement raised above specified tolerances shall be brought to grade by grinding. If over jacking is greater than 0.10 foot (30 mm), satisfactory removal and replacement shall be required, at no cost to the Department.

392.4 METHOD OF MEASUREMENT

PCC Pavement Jacking Slurry will be measured to the nearest cubic foot (0.1 cubic meter). Portland cement will be the only material measured for payment. One bag of cement (94 Pounds) shall equal one cubic foot of PCC pavement jacking slurry (3½ bags of cement [42.64 kg per bag] shall equal 0.1 cubic meter of jacking slurry).

PCC Pavement Jacking Foam will be measured to the nearest pound (kg).

392.5 BASIS OF PAYMENT

PCC Pavement Jacking Slurry will be paid for at the contract unit price per cubic foot (0.1 cubic meters). Payment will be full compensation for all materials, including fly ash, water, labor, equipment, tools, and incidentals required.

PCC Pavement Jacking Foam will be paid for at the contract unit price per pound (kg). Payment will be full compensation for all materials, including high-density polyurethane foam, labor, equipment, tools, and incidentals required.

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